EPA/ROD/R10-94/076
1994

EPA Superfund
Record of Decision:

BANGOR NAVAL SUBMARINE BASE
EPA ID: WA5170027291
OU 02
SILVERDALE, WA
04/15/1994

Text:

PB94-964605
EPA/ROD/R10-94/076
July 1994

EPA Superfund
Record of Decision:

Naval Submarine Base
(O.U. 3), Bangor, WA,
3/28/94

<Figure>

DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

Naval Submarine Base, Bangor
Operable Unit 3
Bangor, Washington

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected action for Operable Unit 3 (OU 3) at the Naval Submarine Base (SUBASE), Bangor in Silverdale, Washington, chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfun Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practical, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). OU 3 consists of three sites: Sites 16 and 24, which are contiguous, and Site 25. The no-action alternative was determined most appropriate because of present site conditions and because associated site risks are within the EPA's acceptable risk range. This decision is based on the administrative record for these sites.

The lead agency for this decision is the United States Navy (Navy). The United States Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) have participated in scoping the site investigations and in evaluating alternatives for remedial action. The EPA and Ecology concur with the selected remedy.

DESCRIPTION OF THE REMEDY

No action, with groundwater monitoring of the shallow aquifer at Site 25. Semiannual groundwater monitoring of the shallow aquifer is necessary to determine whether conditions in the groundwater reflect naturally occurring trends. A 5-year review is necessary to evaluate the need for continued groundwater monitoring at Site 25 and residential construction restrictions

at Site 16/24.

DECLARATION

The selected remedy is protective of human health and the environment and is cost effective. This remedy uses groundwater monitoring to ensure that shallow aquifer conditions at Site 25 remain protective of human health and the environment.

The Navy used EPA guidelines and the information developed during the site investigation to evaluate the potential adverse effects on human health and the environment associated with exposure to site chemicals. The potential exposure of workers and residents to chemicals detected at each site was estimated for current and future scenarios. The evaluation, performed according to EPA's National Contingency Plan and policy guidance, indicated that no action is necessary to be protective to human health and the environment and that risks are within the EPA's acceptable risk range. This evaluation supports the no-action alternative.

Signature sheet for the foregoing SUBASE, Bangor Operable Unit 3, Remedial Action, Record of Decision between the United States Navy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

3/28/94
Date

Captain Ernest R. Lockwood
SUBASE, Bangor Commanding Officer
United States Navy

Signature sheet for the foregoing SUBASE, Bangor Operable Unit 3, Remedial Action, Record of Decision between the United States Navy and the Unite States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

4/15/94
Date

Chuck Clarke
Regional Administrator, Region 10
United States Environmental Protection Agency

Signature sheet for the foregoing SUBASE, Bangor Operable Unit 3, Remedial Action, Record of Decision between the United States Navy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

3/29/94

Carol Kraege, Acting Program Manager Date
Toxics Cleanup Program
Washington State Department of Ecology

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ABBREVIATIONS AND ACRONYMS

ARARs	Applicable or Revelant and Appropriate Requirements
AWQC	Ambient water Quality Criteria
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COPC	chemical of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
FFA	Federal Facilities Agreement
HI	hazard index
HQ	hazard quotient
IAS	initial assessment study
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
msl	mean sea level
MTCA	Model Toxics Control Act (Washington State)
NACIP	Navy Assessment and Control of Installation Pollutants
NAD	Naval Ammunition Depot
Navy	United States Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NTS	Naval Torpedo Station
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
RBSC	risk-based screening concentration
RCRA	Resource Conservation and Recovery Act
RDX	Royal Demolition Explosive (cyclonite or hexahydro-1,3,5-trinitro-1,3,5-triazine)
RfD	reference dose
RI/FS	remedial investigation/feasibility study

ABBREVIATIONS AND ACRONYMS (Continued)

RME	reasonable maximum exposure
SARA	Superfund Amendments and Reauthorization Act of 1986
SQG	sediment quality guidelines
SQL	sample quantitation limit
SUBASE	submarine base
TAL	target analyte list
TCL	target compound list
TEF	toxicity equivalency facto
TNT	2,4,6-trinitrotoluene

g/L micrograms per liter

DECISION SUMMARY

1.0 INTRODUCTION

It is the policy of the United States Navy (Navy) to address contamination at its installations, under the Defense Environmental Restoration Program, in a manner consistent with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). In the case of Operable Unit 3 (OU 3) at the Naval Submarine Base (SUBASE), Bangor the Navy's evaluation of potential adverse effects on human health and the environment indicated that risks at the sites are within EPA's acceptable risk range for current or future uses.

2.0 SITE NAME, LOCATION, AND DESCRIPTION

SUBASE, Bangor is situated on Hood Canal, located in Kitsap County, Washington, approximately 10 miles north of Bremerton (Figure 1). Land surrounding SUBASE, Bangor is generally undeveloped or supports limited residential uses. Naval activities began at Bangor on June 4, 1944, when the U.S. Naval Magazine, Bangor was officially established as a Pacific shipment point for ammunition and explosives. When World War II ended, the Bangor Naval Complex became available for the storage of ordnance.

In 1950, the Naval Magazine facility was consolidated with the Naval Torpedo Station (NTS), Keyport to form the Naval Ordnance Depot, Keyport. In 1952, the facility returned to independent status and became the U.S. Naval Ammunition Depot (NAD), Bangor. In 1963, the Polaris Missile Facility, Pacific became an active tenant of NAD, Bangor. During the late 1960s, conventional weapons used in the Vietnam conflict were loaded on ships from the Bangor Marginal Wharf. NAD, Bangor was responsible for about one-third of all weapons sent to Vietnam between 1965 and 1970. In October 1970, NAD, Bangor was disestablished and became NTS, Keyport. No munitions were shipped from NTS, Keyport between 1970 and early 1972. When bombing runs were stepped up in Vietnam, NAD, Bangor returned to active status. The last shipment to Vietnam was loaded in January 1973.

On November 29, 1973, the Secretary of the Navy announced that the Bangor Naval Complex was selected as the West Coast home port for the Trident Submarine Launched

<Figure>

Figure 1 Site Locations and Geographic Setting

Ballistic Missile System. SUBASE, Bangor was commissioned in February 1977 and the first submarine arrived in August 1982.

On July 22, 1987, Site A was listed on the United States Environmental Protection Agency's (EPA) National Priorities List (NPL) of hazardous waste sites. On August 30, 1990, the remainder of the SUBASE, Bangor facility was listed on the NPL.

On January 29, 1990, a cooperative three-party Federal Facilities Agreement (FFA) was signed by the Navy, EPA, and the Washington State Department of Ecology (Ecology) for study and cleanup of possible contamination on the SUBASE, Bangor property. OU 3 comprises three of the 22 sites potentially contaminated as a result of past waste disposal practices at SUBASE, Bangor. The sites were formed into seven operable units based on geographic location, suspected contamination, or other factors. A separate study is being conducted for each operable unit to determine appropriate cleanup actions.

OU 3, located in the southeastern portion of the base, consists of three sites: Sites 16, 24, and 25. Sites 16 and 24 (hereinafter referred to as Site 16/24) are the former locations of solid- and liquid-waste incinerators and a drum storage area. Site 25, located downgradient of Site 16/24, was included in Operable Unit 3 because of its proximity to Site 16/24 and because of the potential for contaminant migration from Site 16/24 to Site 25 either by surface water or groundwater.

3.0 SITE HISTORY

3.1 SITE 16/24

Site 16/24 is roughly rectangular in shape, covering an area of approximately 1.5 acres (Figure 2). This area was formerly the site of an incinerator and drum storage facility. The single structure on the site is a concrete foundation that previously supported two incinerators. The area around this foundation is secured by a chain link fence, while the remainder of the site is covered with gravel, brush, or trees. The site is approximately 200 feet south of Trident Boulevard (the main road into SUBASE, Bangor) and is bounded by Seadevil Road to the east and Sculpin Circle to the southwest. A number of buildings and parking lots lie to the south. A small drainage swale extends along the western side of the site. The site elevation is approximately 325 feet above mean sea level (msl), with the surface sloping gently to the north. South of the site, the ground

<Figure>

Figure 2 Site 16/24

surface slopes steeply away to the south. The shallow aquifer beneath Site 16/24 generally flows south, toward Site 25.

In addition to the drum storage area and incinerators, Site 16/24 also contains a stack emission area where most of the fallout from the incinerator stack emissions was predicted to settle. The stack emission area was identified by use of an air dispersion model known as EPA SCREEN. The area was identified as immediately north of Site 24 and measuring 270 feet by 60 feet.

Site 16/24 was used as a drum storage area and incinerator site from 1970 to 1983, although actual incineration was not begun until 1973. Drums of wastewater containing 1,2-propanediol dinitrate (Otto fuel); 2,4,6-trinitrotoluene (TNT); hexahydro-1,3,5-trinitro-1,3,5-triazine (also referred to as Royal Demolition Explosive [RDX]); and waste solvents were reportedly stored on Site 16 until their contents could be incinerated at Site 24. Small spills (less than 10 gallons) reportedly occurred at the site, and open drums occasionally overflowed onto the ground during heavy rain.

Site 16/24 contained both a liquid- and a solid-waste incinerator. The liquid-waste incinerator was a Prenco Pyro-Decomposition-Unit. The incinerator was fired with No. 2 fuel oil and reportedly burned RDX and TNT wastewaters ("pink water"), Otto fuel wastewater mixed with solvents, and waste solvents (Hart Crowser 1989). Operational records on actual mixtures and quantities of waste burned, length of burns, operating temperatures, or stack emissions are not available. However, a report published in 1973 stated that the liquid-waste incinerator provided for a maximum burn of 960 gallons of wastewater per 8-hour shift. The incinerator burned at approximately 1,000 C. Additionally, between February and July 1982, approximately 38,600 gallons of Otto fuel wastewater were reported to have been burned in the facility (Hart Crowser 1989).

The solid-waste incinerator was an MK-VI Radicator with Torpedo option, fired by gaseous butane. The unit was used to burn contaminated solid waste, including rags, sawdust, and protective clothing contaminated with Otto fuel. Beginning in 1977, carbon filters contaminated with Otto fuel were also destroyed in the solid-waste incinerator. Records are not available on the total quantity of solid waste incinerated using the unit.

Both the solid-waste and liquid-waste incinerators were deactivated in 1983 and removed from the site in 1987 because of the projected inability of the incinerators to meet future air emission and Resource Conservation and Recovery Act (RCRA) requirements.

Information regarding the final disposition of the incinerators and any residual wastes is not available.

3.2 SITE 25

Site 25 was formerly the location of a sewage treatment plant outfall from the industrial area of NAD, Bangor and presently consists mainly of two earthen stormwater detention/retention ponds, which cover an area of approximately 1.2 acres (Figure 3). These stormwater detention/retention ponds were constructed in 1983, at which time the entire area was regraded. The site is bounded by Sculpin Circle to the north and west and the Southern Boundary Road to the east. A wooded area lies directly to the south. There is a residential area outside the base boundary to the southeast. A solid-waste transfer station is located just beyond the southwestern corner of the site, and there are an office building and a gravel parking area north of Sculpin Circle. The site elevation is approximately 275 above msl Groundwater flow is generally to the south.

Site 25 includes an oil/water separator that provides initial treatment of stormflow prior to its discharge into the central branch of Clear Creek, an ephemeral stream outside the base boundary and adjacent to the site. Surface water and sediments in Clear Creek were included in the investigation of Site 25.

As stated, Site 25 was the location of the outfall from the former sewage treatment plant for NAD, Bangor. The sewage treatment plant, Building 427, constructed in 1942 to serve the industrial and barracks area, was formerly located west of Site 25. The facility consisted of a two-stage biofiltration system and reportedly had a design capacity of 52,000 gallons per day (Hart Crowser 1989). The treated outfall from the plant was discharged directly into the central branch of Clear Creek, which ultimately discharges into Dyes Inlet of Puget Sound. Wastewater was diverted to the Kitsap County treatment system (Brownsville District) in 1977 during the construction of SUBASE, Bangor and the sewage treatment plant was removed. A parking lot now occupies the area of the former sewage treatment plant.

In a pilot study to determine the concentration of RDX and TNT in wastewater prior to its discharge into Clear Creek, approximately 1,500 gallons of wastewater known to contain 200 parts per million (ppm) each of RDX and TNT was processed through the sewage treatment system and discharged. The pilot study was considered a success, as no RDX or TNT were detected in the effluent. In 1983, the area in and around the sewage treatment plant outfall was reconstructed as two stormwater detention/retention

<Figure>

Figure 3 Site 25

ponds, equipped with an oil and water separator treatment unit. These ponds and the oil and water separator provide initial stormflow treatment for surface water prior to its discharge into the central branch of Clear Creek.

4.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

Community relations activities have established communication among citizens living near the site, the Navy, EPA, and Ecology. The actions taken to satisfy the requirements of the federal law (cited below) have also provided a forum for citizen involvement and input to the remedial action decision. No fact sheet was issued specifically for this site, however, a fact sheet was issued in May 1992 which discussed the OU 3 remedial investigation activities.

The specific requirements for public participation pursuant to CERCLA [Para][Para]113 (k) (2) (b) and 117(a) as in 42 USC [Para]9617 (2), as amended by SARA, include releasing the proposed plan for remedial action to the public. The proposed plan for remedial action was placed in the administrative record and information repositories.

The administrative record is on file at:

Engineering Field Activity, Northwest
Naval Facility Command
1040 N.E. Hostmark Street
Olympic Place II
Poulsbo, Washington
(206) 396-5984

The information repositories are located at:

Central Kitsap Regional Library
1301 Sylvan Way
Bremerton, Washington
(206) 377-7601

SUBASE, Bangor Branch Library
Naval Submarine Base, Bangor
Bangor, Washington
(Base access is required)
(206) 779-9274

The proposed plan for remedial action was mailed to all known interested parties in May 1993. Notice of the availability of the proposed plan, plus notice of a public meeting on the proposed plan and public comment period was published in The Sun (Bremerton) on May 10, 1993. A public comment period was held from May 10, 1993, to June 9, 1993. A public meeting was held on May 19, 1993, at the Clear Creek Elementary School gymnasium in Silverdale, Washington. A total of 31 people attended.

One public comment was received by the Navy concerning the proposed plan for remedial action at Operable Unit 3. It was submitted at the public meeting. The public comment is summarized in the Responsiveness Summary (Attachment 1).

5.0 SCOPE AND ROLE OF OPERABLE UNITS

Operable Unit 3 consists of 3 sites: Sites 16 and 24, which are contiguous and addressed together, and Site 25. Risks associated with all three sites are within the EPA's acceptable risk range and do not warrant remedial action. Ecology's concerns about exposure to surface soils have been addressed by residential use restrictions, which have been put in place by the Navy at Site 16/24 (Attachment 2). The monitoring of groundwater at Site 25 will ensure that conditions remain protective of human health and the environment.

6.0 SUMMARY OF SITE CHARACTERISTICS

The remedial investigation of Site 16/24 included sampling of the site's surface and subsurface soils, groundwater, and sediments. The remedial investigation of Site 25 included sampling of the site's subsurface soils, groundwater, and sediments, as well as surface water and sediments in Clear Creek. No surface soil sampling occurred at Site 25, because when the site was regraded in 1983, surface soil was disturbed and/or removed. Analytical results from background sampling were used to establish naturally occurrin levels of inorganic chemicals to distinguish them from increased levels resulting from activities on site. The analyses included all compounds from the EPA target compound list (TCL) (semivolatile and volatile organics and pesticides/polychlorinated biphenyls [PCBs]), all analytes from the EPA target analyte list (TAL) (metals and cyanide), ordnance compounds, chlorinated herbicides, polychlorinated dibenzofurans/dibenzodioxins, and water quality parameters.

6.1 SITE 16/24

6.1.1 Surface Water

Surface water on this site exists only in stormwater drainage ditches, during periods of intense rain. Surface water samples were not collected during the field investigation because there was insufficient runoff.

6.1.2 Sediment

There were two sediment sampling events. Four locations in the small drainage swale located to the west of the site, or in roadside runoff collection ditches adjacent to the site, were sampled during each event. Samples were analyzed for TCL and TAL compounds, herbicides, dioxins, furans, and ordnance compounds.

Findings: Table 1 lists maximum, minimum, and mean concentrations of all chemicals detected in sediments at Site 16/24, along with detection frequency. All values for organic compounds were below potential applicable or relevant and appropriate requirements (ARARs).

6.1.3 Surface Soils

Nine surface soil samples from Site 16/24 and 16 surface soil samples from the stack emissions area were collected and submitted to a laboratory for

analysis of TCL and TAL compounds, herbicides, and ordnance compounds. The 16 initial samples and two additional samples from the stack emissions area were also analyzed for dioxins and furans. In addition, 21 samples were field-screened for RDX and TNT in a mobile laboratory.

Findings: Table 2 lists maximum, minimum, and mean concentrations of all chemicals detected in surface soils at Site 16/24, along with detection frequency. Beryllium was detected in all surface soil samples at concentrations two to six times higher than background levels, and arsenic and antimony were detected above background levels and potential ARARs.

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6.1.4 Subsurface Soils

Seven monitoring wells were installed in three well clusters at Site 16/24, surmounting all gradient areas. The well installation generated 75 subsurface soil samples collected at 5-foot intervals to a depth of 60 feet and then at 10-foot intervals to termination depth in the Kitsap Formation. Samples were analyzed for TCL, TAL, and ordnance compounds.

Ten shallow soil borings were completed, generating 45 soil samples. The samples were collected every 2.5 feet continuously from the ground surface to a depth of 10 feet. Samples were analyzed for TCL and TAL compounds, herbicides, dioxins, furans, and ordnance compounds.

Findings: Table 3 lists maximum, minimum, and mean concentrations of all chemicals detected in subsurface soils at Site 16/24, along with detection

frequency. The results of the soil analysis indicate that metals concentrations decrease dramatically with depth and that surface metals do not migrate or leach downward through the soil in this area. Volatile and semivolatile compounds detected were deemed laboratory artifacts. Pesticides and PCBs were not detected. Three ordnance compounds were detected, showing a sporadic distribution.

6.1.5 Groundwater

Two rounds of groundwater sampling of the shallow aquifer occurred, during September 1991 and January 1992. Fourteen samples were analyzed for water quality parameters, TCL, TAL, and ordnance compounds during the first round. Chlorinated herbicides were added in the second round. In addition, the groundwater level elevation was taken seven times to determine potentiometric surface across the site. The shallow aquifer under the site flows generally south.

Findings: Table 4 lists maximum, minimum, and mean concentrations of all chemicals detected in groundwater at Site 16/24, along with detection frequency. Volatile and semivolatile compounds detected in groundwater were deemed laboratory artifacts and false positives, because of sporadic distribution. With the exception of acetone, 2-butanone, and bis(2-ethylhexyl)phthalate (which are common laboratory artifacts), the majority of detected organic compounds were found at concentrations near their detection limits, were not present in the same well during both rounds of sampling, and were not present in more than one well per sampling event. No PCBs were detected. The one pesticide compound detected was considere anomalous. Four ordnance

<Figure>

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compounds were detected at concentrations below potential ARARs. The higher-than-background metals concentrations in the deep-screened well are

attributed to high pH resulting from improper well construction, poor well development, and the natural enrichment of metals in the Kitsap Formation.

6.2 SITE 25

6.2.1 Surface Water

Two rounds of surface water samples were collected at four locations at Site 25 from the effluent culverts that discharge into the detention/retention ponds and Clear Creek. The samples were analyzed for water quality parameters, herbicides, TCL, TAL, and ordnance compounds.

Two rounds of surface water samples were collected from five locations on Clear Creek. The first sample round was collected during low-flow conditions and the second during high-flow conditions. First-round samples were analyzed for water quality parameters, herbicides, TCL, TAL, and ordnance compounds; the second round of samples was analyzed only for ordnance compounds.

Findings: Tables 5 and 6 list minimum, maximum, and mean concentrations of all chemicals detected in surface water at Site 25 and Clear Creek, along with detection frequency.

At Site 25, no volatiles, semivolatiles, pesticides, or PCBs were detected in any surface water sample. Two ordnance compounds were detected in the effluent culverts: 1,3,5-trinitrobenzene and picramic acid. Total beryllium, copper, iron, lead, and zinc were detected above the most restrictive potential ARARs.

At Clear Creek, total arsenic, lead, cyanide, iron, and vanadium were detected above the most restrictive potential ARARs. Only one organi compound, bis(2-ethylhexyl)phthalate, was detected at Clear Creek.

Runoff for Site 25 and Clear Creek does not originate from a discrete source, so elevated metals concentrations cannot be correlated to a source.

<Figure>

6.2.2 Sediment

There were two sediment sampling events at Site 25. Samples were collected at the same locations as were surface water samples. Sediments samples were analyzed for TCL and TAL compounds, herbicides, and ordnance compounds.

Two rounds of sediment samples were collected from the five surface water sample locations on Clear Creek. The first sample round was collected during low-flow conditions and the second during high-flow conditions. First-round samples were analyzed for TCL, TAL, and ordnance compounds; the second round of samples was analyzed only for ordnance compounds.

<Figure>

Findings: Table 7 lists maximum, minimum, and mean concentrations of all chemicals detected in sediments at Site 25, along with detection frequency. At Site 25, analysis of samples from the first sampling event detected few organic compounds. Analysis of samples from the second event detected more organic compounds, but with no pattern of distribution. The concentrations of analytes in sediment samples from the swale do not indicate surface water runoff as a contaminant source.

Table 8 lists maximum, minimum, and average concentrations for all chemicals detected in sediments at Clear Creek, along with detection frequency. At Clear Creek, analytical results from the first sampling event showed organic compounds (several polycyclic

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aromatic hydrocarbons [PAHs] and one ordnance compound) at the detention pond outfall to the central branch of Clear Creek. Samples from the second event were analyzed only for ordnance compounds; none were detected.

6.2.3 Subsurface Soils

Five monitoring wells were installed in three well clusters at this site, surmounting all gradient areas. The well installations generated 55 subsurface soil samples collected at 5-foot intervals to a depth of 60 feet and then at 10-foot intervals to termination depth in the Kitsap Formation. Samples from the three deepest wells were analyzed for TCL, TAL, and ordnance compounds.

Findings: Table 9 lists maximum, minimum, and mean concentrations of all

chemicals detected in subsurface soils at Site 25, along with detection frequency. The results of the analysis of the soil samples indicate that organic and ordnance compounds had a low frequency of detection. Metals concentrations were representative of background concentrations.

6.2.4 Groundwater

Two groundwater sampling rounds occurred, one in September 1991 and one in January 1992. Samples were analyzed for TCL, TAL, and ordnance compounds, chlorinated herbicides, and general water quality parameters. A third round of sampling for only benzene, toluene, ethylbenzene, and xylene was conducted at one well.

Findings: Table 10 lists maximum, minimum, and mean concentrations of all chemicals detected in groundwater at Site 25, along with detection frequency. Organic and ordnance compound detections in the groundwater samples were considered questionable because the compounds encountered were sporadically distributed. Metals concentrations were generally below background concentrations and potential ARARs. The exceptions were manganese and cadmium. Manganese was detected in several wells at concentrations above background and potential ARARs. Cadmium was detected in one well at levels above background and potential ARARs in both sampling rounds.

<Figure>

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7.0 SUMMARY OF SITE RISKS

7.1 HUMAN HEALTH RISK ASSESSMENT AND CHARACTERIZATION

The baseline risk assessment in Section 6.0 of the Remedial Investigation/Feasibility Study (RI/FS) (URS 1992) estimated the probabilities of adverse health effects from current and future hypothetical exposures to chemicals of concern in the absence of remediation. The risk assessment is a multistep process consisting of data evaluation, chemical toxicity assessments, and exposure assessments. By combining the information gathered from each of these three tasks, noncancer and cancer risks can be quantified in a final step termed risk characterization.

All chemicals detected at Sites 16/24 and 25 and in background samples were initially screened according to EPA guidelines to select chemicals of potential concern (COPC). A detailed exposure assessment followed, which consisted of evaluating the specific exposure setting and exposure pathways.

Default exposure assumptions were defined in current EPA risk assessment guidance. (Site-specific exposure assumptions are explained in Section 6.0 of the RI/FS.) Toxicity information obtained from EPA's IRIS database was then applied to each COPC.

Noncancer risks were quantified by comparing the estimated intake dose resulting from site exposure to a reference dose (RfD), an EPA estimate of acceptable intake of a chemical per day. Hazard indexes (HIs) greater than 1 were considered a concern.

Noncarcinogenic hazard quotients (HQs) for adults were calculated using chemical intakes combined with chronic reference doses, because exposures were assumed to last more than 7 years. For two exposure pathways (i.e., soil ingestion and dermal contact), reasonable maximum exposure (RME) assumptions were specified for both children and adults. For these exposure pathways, subchronic risks were calculated separately for the childhood exposure. Because childhood exposure lasts for 6 years, subchronic RfDs were used to calculate HQs.

Cancer risks were expressed as an excess probability that an individual will develop cancer if exposed to a chemical over a lifetime. The NCP states that acceptable risks lie between 10[-4] and 10[-6]. For example, a risk expressed as 1 x 10[-6] means that one person in 1,000,000 individuals exposed may develop cancer over a lifetime of exposure to the specified chemicals at the site.

Four scenarios were evaluated: the current worker, future worker, future resident, and Clear Creek recreational visitor (for only Site 25) scenarios. These scenarios were evaluated on the basis of cancer and noncancer risks for all significant pathways of exposure.

7.1.1 Site 16/24

The COPC for Site 16/24 are presented in Table 11. The primary chemicals of concern contributing to the total risk at Site 16/24 are arsenic, barium, and beryllium in groundwater.

The total hazard index and cancer risk for all pathways in each scenario are shown in Table 12. The hazard index and cancer risk associated with naturally occurring background conditions are shown in Table 13

The excess noncancer hazard index (summed across all chemical and exposure pathways) and excess cancer risk for current and future projections for Site 16/24 are shown in Table 14. These excess risks do not include risks from inorganics, which were attributed to naturally occurring conditions and are not related to previous activities at the site.

Excess noncancer risk at Site 16/24 for all exposure scenarios is negligible. Excess cancer risk for the future residential scenario (the most conservative) is 1 in 50,000 (2 x 10[-5]). All excess risks associated with Site 16/24 are within the EPA's acceptable risk range. The chemicals

that most contribute to this risk are beryllium and Aroclor 1245 in soils, and benzene and lindane in groundwater.

7.1.2 Site 25

The COPC at Site 25 are presented in Table 15. The primary chemicals of concern contributing to the total risk at Site 25 are arsenic and manganese in groundwater and cadmium in groundwater and soils.

The total excess noncancer hazard index (summed across all chemical and exposure pathways) and excess cancer risk for current and future projections for Site 25 are shown in Table 16. These excess cancer risks do not include risks from inorganics, which were attributed to naturally occurring conditions and are not related to previous activities at the site.

<Figure>

<Figure>

<Figure>

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The total hazard index and cancer risk for all pathways in each scenario are shown in Table 17. The hazard index and cancer risk associated with naturally occurring background conditions are the same as presented for Site 16/24 (Table 13).

Excess noncancer risk at Site 25 for all exposure scenarios is negligible. Excess cancer risk for the future residential scenario is 1 in 12,500 (8 x [10-5]). All excess risks associated with Site 25 are within the EPA's acceptable risk range.

7.2 ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment for OU 3 was presented qualitatively in the RI/FS (URS 1992), rather than quantitatively, because of the disparities in the quality of habitats at the sites and adjacent areas

<Figure>

<Figure>

Sites 16/24 and 25 are industrialized sites that provide relatively low-quality habitat for populations or communities of local flora and fauna. Site 16/24 is covered in part by an enclosed concrete pad, and much of the remainder of the site is covered with sand and gravel. These substrates do not support vegetation or browsing for wildlife. Site 25 is covered with mostly wetland species. The bermed areas around Site 25's ponds are regularly mowed. Under these conditions, this site is not likely to be colonized by more desirable vegetation.

Areas that are adjacent to Sites 16/24 and 25, or that potentially receive runoff from these sites, contain shrub, deciduous, coniferous, and aquatic habitats. Data on chemical concentrations in soils, sediments, and surface water are available for Sites 16/24 and 25, but not for the adjacent areas.

The overall emphasis of the environmental evaluation was on the potential chemical exposure to adjacent habitats that may result from off-site transport of chemical contaminants and on the potential exposure of organisms that may be sporadic and transitory visitors to the sites. The qualitative nature of this ecological evaluation was further dictated by the high degree of uncertainty in the frequency and duration of exposure to biota whose presenee at these sites is probably sporadic and transitory.

Some COPC in surface water and sediments at the point of the discharge from Site 25 to the headwaters of the central branch of Clear Creek (an ephemeral stream) exceeded respective ambient water quality criteria (AWQC) or sediment quality guideline (SQG) values. However, the concentrations of these COPC in sediments or surface water seem

<Figure>

to be confined to the headwaters of Clear Creek's central branch. With the exception of beryllium and vanadium, COPC concentrations in sediments and surface water in the lower reaches of the central branch of Clear Creek were below AWQC and SQC values, or were comparable with reference area concentrations. There were no SQGs available to assess the toxicity of beryllium and vanadium. Where the central branch of Clear Creek meets the west fork of Clear Creek, water quality and sediment quality guidelines were attained. Although the central fork of Clear Creek is a low-gradient system, severe stormwater runoff provides adequate flushing. Compliance with water quality and sediment quality guidelines was attained in the lower reaches of the stream

With the exception of aquatic habitats at Site 25, this analysis indicated that potential ecological risks to biota in the vicinity of these sites are

negligible.

7.3 UNCERTAINTY ANALYSIS

Sources of uncertainty identified in this risk assessment are summarized in Table 18. For each source of uncertainty, the possible effect on the risk estimate (i.e., underestimation or overestimation), the degree of such effect, and the steps taken to mitigate the uncertainty are noted.

7.3.1 Data Evaluation

Uncertainties associated with the data evaluation include unavailable toxicity data, missing data for the detention/retention ponds, poor quality for ordnance data, and the detection of chemicals at low frequencies and at low concentrations.

Toxicity data were not available for the following detected analytes: lead, phenanthrene, and 4-chloro-3-methylphenol. Lead was evaluated separately from the other COPC by comparing concentrations in soil and water with acceptable concentrations recommended by EPA. This approach does not allow for summation of risks associated with lead and other COPC and, therefore, results in underestimation of the total risks associated with both sites.

For the purposes of calculating risk-based screening concentrations (RBSCs), the RfDs for fluoranthene and 3,4-dimethylphenol were used as surrogates for phenanthrene and 4-chloro-3-methylphenol, respectively. Phenanthrene and 4-chloro-3-methylphenol were screened out of the risk assessment on the basis of these surrogate screening concentrations. This process is not expected to be a large source of uncertainty.

<Figure>

Surface water and sediment samples were not directly obtained from the retention ponds at Site 25. However, it was assumed that the culvert sediment and surface water samples at the oil and water separator were representative of the contaminants in the ponds.

The ordnance data were qualified with the flag UJ because holding times were exceeded. (UJ indicates an undetected value with an estimated detection limit.) Upon reevaluation of the ordnance data, a small portion of the values were re-qualified as detected. Comparisons of these values with RBSCs eliminated all but Otto fuel from the risk assessment. Elimination of analytes from the risk assessment on the basis of estimated detection limits could cause underestimation of risks, but this is not expected to be a large source of uncertainty.

Bis(2-chloroethyl)ether was detected only once at Site 16/24: in groundwater at the sample quantitation limit of 10 g/L, which means that the

concentrations are uncertain. The compound was not detected in soil, whic suggests that there is no source for this chemical on Site 16/24. Bis(2-chloroethyl)ether could not be excluded from the risk assessment because the detected value (at the sample quantitation limit) exceeds the RBSC of 0.29 g/L. Bis(2-chloroethyl)ether dominates risks for groundwater through both the ingestion and the inhalation pathways. However, there is a great deal of uncertainty associated with the risk results for this chemical.

Otto fuel was detected twice at Site 25: in groundwater at concentrations below the sample quantitation limit of 0.2 g/L, which means that the concentrations are uncertain. Otto fuel was not detected in soil. It could not be excluded from the risk assessment because the maximum detected value of 0.09 g/L exceeds the RBSC of 0.0063 g/L. Because of large uncertainties about the toxicity data for Otto fuel, risks for this chemical are explored further (Section 7.3.4) in this uncertainty analysis.

7.3.2 Toxicity Assessment

Four of the carcinogens evaluated in the risk assessment (arsenic, benzene, chromium VI, and nickel) are classified by the EPA as Group A (known human carcinogens). For these chemicals, there is little uncertainty regarding their carcinogenicity in humans.

Most of the remainder of the carcinogens are classified by the EPA as Group B2 (probable human carcinogens) based on no evidence in humans but sufficient evidence in animals. There are a number of uncertainties regarding evidence of carcinogenicity

based on animal tests. One uncertainty is the use of maximum tolerated doses that cause cellular damage, which increases the rate of cell growth during repair processes. High rates of cell growth predispose an animal to developing cancer. Another source of uncertainty is the assumption that all chemicals that are carcinogenic in animals are also carcinogenic in humans. Therefore, for chemicals classified as Group B2, lack of evidence of carcinogenicity in humans produces considerable uncertainty in the carcinogenic risk estimates.

Uncertainty factors for the majority of the RfD values were in the range of a hundred or a thousand. This indicates considerable uncertainty regarding the actual values of the RfDs for these chemicals. On the other hand, the uncertainty factors for the oral RfDs for arsenic, barium, and manganese were less than 10. This indicates very little uncertainty about the actual values for these RfDs.

Currently, EPA does not provide an RfD for Otto fuel. Risks associated with Otto fuel were evaluated using an RfD based on the limited toxicological database for 1,2-propanediol dinitrate, Otto fuel's major component. The RfD is highly uncertain because it is based on an inadequate toxicological database and because it has not been subjected to peer review. For this reason, risks for Otto fuel were evaluated in the uncertainty analysis of

the RI/FS instead of in the risk characterization.

Concentrations of cPAHs (carcinogenic PAHs) were summed to allow the evaluation of compounds that do not have toxicity values. Slope factors for benzo(a)pyrene were used as a surrogate for all carcinogenic PAH compounds Since benzo(a)pyrene may be the most potent cPAH, aggregating cPAHs in this fashion may serve to overestimate risks. However, until more toxicity data are available on these compounds, it is not possible to conduct more chemical-specific evaluations.

Toxicity equivalency factors (TEFs) were used to combine concentrations of dioxins and furans in a toxicity-weighted fashion. The toxicity equivalency factor method is based on structure-activity relationships. However, EPA (1989c) and its Science Advisory Board note that the TEF method may lack scientific validity. Use of the TEF method may cause underestimation or overestimation of risk.

Risks associated with dermal contact with soils were evaluated only for nonvolatile organic chemicals; it was assumed that volatile chemicals would evaporate prior to absorption. Because most metals are not absorbed easily through the skin, the dermal route is not expected to contribute substantially to total risks for metals. EPA (1991b) is in the process of revising its approach to evaluating exposure via dermal contact. There is a great deal of uncertainty regarding the absorption rates used for both the dermal and the oral routes of exposure.

Dermal contact with water was evaluated only for nonvolatile organic chemicals. It was assumed that volatile chemicals would tend to evaporate too quickly to be absorbed through the skin. It was also assumed that metals would not be absorbed well through the skin. EPA (1991b) is in the process of developing guidance for evaluating the dermal exposure route. There is substantial uncertainty regarding the permeability constants used for dermal contact with water.

Carcinogenic PAHs were not included in the evaluation of dermal exposure pathways because they cause cancer at the site of contact (skin). Evaluation of absorption through the skin and systemic distribution and health effects is inappropriate for a health effect that occurs at the site of contact. There are no dermal toxicity data for cPAHs and, therefore, this route of exposure could not be evaluated. This causes underestimation of risks for the Site 25 occupational exposure scenarios and the Clear Creek recreational scenario.

7.3.3. Exposure Assessment

Most of the assumptions in the exposure assessment used default values recommended by EPA (1991a) to standardize risk assessments. Uncertainties regarding exposure assumptions stem from the natural variabilities of parameters, such as body weight or soil ingestion rate, as well as from insufficient data on the distribution of these parameters.

The exposure point concentrations for groundwater are based on total, not dissolved, metals concentrations. This conservative approach may overestimate risk.

Contaminant concentrations in soil and groundwater were assumed to remain constant throughout the duration of exposure. This assumption is reasonable for the inorganic contaminants in soil. However, for organic contaminants with significant removal processes (e.g., volatilization, microbia degradation), this assumption may result in overestimation of risk. Assumption of constant concentrations in groundwater over a 30-year period is not entirely realistic. It is not possible to know whether this assumption over- or underestimates risk.

7.3.4 Risk Characterization

When risks are summed across chemicals, it is assumed that the chemical-specific risks are independent and additive. In actuality, these risks may interact to produce an effect that is less than additive (antagonism) or an effect that is more than additive (synergism). Unfortunately, data on chemical interactions are lacking for most chemical mixtures. In the absence of mixture-specific toxicity data, the assumption of additivity is a standard approach. This may result in overestimation or underestimation of risk.

ù Risk Characterization for Otto Fuel

As previously mentioned in Section 7.3.1, the RfD that was calculated for Otto fuel is highly uncertain and not verified by the EPA. In addition, Otto fuel was detected only once in 13 samples at Site 16/24, at a concentration of 1.2 g/L, and only twice in 11 samples at Site 25, at a maximum concentration of 0.89 g/L. Thus, average and RME concentrations for Otto fuel were calculated to be less than 1 g/L, a concentration significantly below the sample quantitation limit (SQL) of 4 g/L, and were found to constitute significant noncancer risks. As a result, the decision was made to evaluate the noncancer risks associated with Otto fuel in the uncertainty analysis.

Table 19 shows the results for groundwater ingestion and dermal contact with groundwater for the future residential scenario at both sites. For both sites, the RME HQs associated with the ingestion of groundwater exceed unity, the level of concern. The total RME HIs across both pathways for Sites 16/24 and 25 were estimated to be as high as 3.6 and 2.7, respectively. In both cases, the ingestion of groundwater contributes approximately 80 percent of the total noncancer effects.

<Figure>

8.0 DESCRIPTION OF THE NO-ACTION ALTERNATIVE

The baseline risk assessment showed that excess noncancer and cancer risks for the hypothetical future resident (the most conservative scenario) were 0.06 and 2 x 10[-5] (1 in 50,000) for Site 16/24 and 0.20 and 8 x 10[-5] (1 in 12,500) for Site 25. All of these risks are within the EPA's acceptable risk range and no remedial action is necessary. However, there are exceedances of Washington State's Model Toxics Control Act (MTCA) in surface soils at Site 16/24 and in groundwater at Site 25. These exceedances are summarized in Tables 20 and 21.

<Figure>

The concerns of Ecology have been addressed at Site 16/24 by residential use restrictions and controls established under the authority of the SUBASE, Bangor Commanding Officer (see Attachment 2). Property transfers for Site 16/24 will require

<Figure>

deed restriction to be attached and will have to meet the requirements of CERCLA Section 120(h) and WAC [Para]173-340-440.

At Site 25, a semiannual groundwater monitoring program of the shallow aquifer will be developed jointly by the Navy, EPA, and Ecology and implemented by the Navy to verify that the levels of chemicals observed are consistent with naturally occurring background levels. The Navy, EPA, and Ecology will compare data from the monitoring program with federal maximum contaminant levels (MCLs), MTCA Method B levels, and representative background concentrations to determine if additional monitoring or other actions are necessary. If agreement is not reached on the design and implementation of the monitoring program, or as to whether further action is necessary as a result of the monitoring program data, the dispute resolution provisions of the Federal Facilities Agreement for SUBASE, Bangor may be invoked.

At the required 5-year review, the Navy, EPA, and Ecology will re-evaluate the need for continued monitoring at Site 25 and residential use restrictions at Site 16/24.

9.0 EXPLANATION OF SIGNIFICANT CHANGES

There are no substantive changes from the proposed plan for remedial action at Operable Unit 3. Minor changes are administrative, owing to residential use restrictions that have been initiated since the proposed plan was released for public comment on May 10, 1993. That proposed plan identified limited action as the preferred alternative. The proposed limited action consisted of future residential restrictions at Site 16/24 and a 5-year groundwater monitoring program at Site 25. Another alternative was a no-action alternative. The original preference for the limited-action alternative was

based on the need to restrict future residential use at the sites and to implement a 5-year groundwater monitoring program.

Subsequent to the public review period, the Navy imposed the residential restrictions referenced above and included these restrictions in its master plan. If the base should close, notification of the history of the site will be attached to any property transfer. That decision was based on several factors, including the concentrations of contaminants in relation to risk-based or regulatory levels, the location of the sites with respect to the base boundaries, the presence or absence of potential receptors, and the presence or absence of identifiable source areas. The concentrations of contaminants at Sites 16/24 and 25 are relatively low in comparison with risk-based levels and primary maximum contaminant levels. No sources o groundwater contamination were identified, and contaminants are confined within the base boundaries. Consequently, ongoing monitoring and evaluation of the groundwater (which is not considered a remedial action), in addition to the residential restrictions already imposed, are appropriate for these sites.

10.0 REFERENCES

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Attachment 1

RESPONSIVENESS SUMMARY

One comment was received during the public comment period held May 10, 1993, through June 9, 1993. It was received at a public meeting held at the Clear Creek Elementary School in Silverdale, Washington. The responsiveness summary addresses the public comment received on the proposed plan for remedial action at Sites 16, 24, and 25.

1.0 SUMMARY OF PUBLIC COMMENT

One comment was received by the Navy concerning the proposed plan. This was an oral comment raised at and responded to during the public meeting. The public meeting was recorded on a transcript, which is available at the information repositories.

Summary of Comment: A member of a community organization stated that the

organization had reviewed technical documents regarding the proposed plan. The organization agreed with the proposed plan and felt the Navy had done a good job during the investigations. The speaker thanked the Navy for the opportunity to participate in the process and expressed interest in remaining involved in the development of the monitoring program and its results.

2.0 RESPONSE TO COMMENT

Response: The Navy appreciates the comment regarding the quality of the documents and investigations. The Navy encourages and values public participation in this process. The Navy will issue periodic fact sheets which, when appropriate, will include information regarding the sampling activities at Site 25.

Attachment 2

RESIDENTIAL CONSTRUCTION RESTRICTION

DEPARTMENT OF THE NAVY

NAVAL SUBMARINE BASE, BANGOR

SILVERDALE, WA 98315-1199

From: Commanding Officer, Naval Submarine Base, Bangor

Subj: OPERABLE UNIT 3

Ref: (a) Naval Submarine Base, Bangor Master Plan

Encl: (1) Figure 1 of the Installation Restoration Program

1. Per reference (a), no residential construction will occur in the restricted construction area outlined in enclosure (1) while under Navy cognizance.

E. R. LOCKWOOD

<Figure>

FIGURE 1 SITE 16/24